ANALYSIS OF THE PRECIPITATION OF RAINS AND SNOWS AT MOUNT VERNON, IOWA

By LYLE L. COTTRAL

[Cornell College, Mount Vernon, Iowa]

Under the direction of Dr. Nicholas Knight, Cornell College, Mount Vernon, Iowa, has for the last 20 years carried on an analysis of the rain and snow precipitated here. The results of much of this work have been published in periodicals of a scientific nature.

The precipitations are collected in clean granite pans, away from trees and buildings, and stored in glass stoppered bottles. The town has no factories and, exclusive of the college, has a population of about 1,700. The sulphuric acid found comes therefore mainly from the coal used in private heating plants. It has been found necessary to deduct 3.55 parts per million from the reading to allow for the formation of the color in the test for the chlorides. The precipitations come from the east or the south, which signify that the salt is carried by the winds from the Atlantic Ocean or the Gulf of Mexico. Due to some criticism special care has been taken in the analysis of the chlorides, which, after considerable work, we have reason to believe correct. The phenoldisulphonic acid method was used with the nitrates. All of the samples were colorless.

The methods used in the analysis are taken from the Standard Methods of Water Analysis, sixth edition, published by the American Health Association.

TABLE 1

No. of sample	Date of precipitation, 1930	Amount	Rain or snow	Nitrates	Nitrites	Free ammonia	Albuminoid ammonia	Sulfates	Chlorides
1	May 5	0.6	Rain	0.04	0.0001	0.056	Traces.		14.2
2	May 6	0.25	do	0.06	Traces.	0.04	Traces.		7.1
3	June 5	1.5	do	0.06	Traces.	Traces.	Traces.		15.62
4	June 13	0.25	do	0.32	Traces.	Traces.			21.30
5	June 14	0.35	do	0.64	Traces.	Traces.	0.0032		
6	June 15	3.	do	0.64	Traces.	Traces.	Traces.		14.2
7	June 25	0.2	do	0.32	0.0002	Traces.			24.85
8	June 30	0.45	do	0.64	0.0004	0.054	Traces.		28.40
9	Sept. 25	0.25	do	0.64	Traces.	0.08	Traces.		
10	Sept. 26	2.0	do	0.64	Traces.	0.08			38.50
11	Oct. 6	0.25	do	0.32	0.004				31.95
12	Oct. 7	1.90	do	0.64	0.0001	Traces.			31.95
13	Oct. 16	0.75	do	1.28	0.001	0.064	0.931	0.012	31.95
14	Oct. 29	0.20	do	0.64	Traces.	0.072.			17.75
15	Oct. 30	0.20	do	0.56	0.0002	0.0752	0.0416		
16	Nov. 15	0.25	do	0.64	0.0017	0.08	0.120	0.044	24.95
17	Nov. 16	1.00	do	0.64	0.0001	Traces.	Traces.		24.95
18	Nov. 20	0.4	do	1.28	0.001	0.200	Traces.		
19	Nov. 25	4.	Snow	0.32	Traces.	0.078	0.0496		37.15
20	Nov. 30	0.6	Rain	0.64	0.0008	0.0288	0.0160		
21	Dec. 5	0.7	do	0.32	0.001	0.0272	Traces.		14.2
22	Dec. 13	5.00	Snow	0.64	Traces.	0.016	0.0144	0.024	17.75
23	Dec. 18	4.	do	0.64	0.0006	0.0192	0.0048	0.146	
24	Jan. 18	4.	do	0.64	0.0002	0.064	0.0032	0.428	3.55
25	Feb. 6	3.	do	0.64	0.001	0.144	0.192	0.218	10.65
26	Mar. 7	4.	do	1.28	0.0004	0.72	0.04	0.184	3.55
27	Mar. 24	0.3	Rain	0.56	0.0004	0.448	0.98	0.104	3.55
28	Mar. 27	4.	Snow	0.64	0.0004	0.04	0.64	0.068	3.55
29	Mar. 28	15.0	do	0.48	Traces.	0.04	0.04	1.68	7.10
30	Apr. 3	0.15	Rain		0.0544	0.800	0.490	3.4	7.10
31	Apr. 9	0.10	do	0.64	0.0128			0.30	10.65
32	Apr. 16	0.4	do	1.28	Traces.	1.60	0.640	1.4	3.55
33	Apr. 19	0.8	do	0.74	0.0001	0.52	0.245	2.00	3.55
34	Apr. 20	0.5	do	0.64	Traces.	1.200	0.160	1.30	3.55
35	Apr. 21	0.5	do	0.64	0.0001	0.32	0.136	3.60	3.55
36	May 5	0.1	do	0.64	0.001	0.89	0.490	2.00	7.10
37	May 9	0.5	do	1.28	0.0002	0.544	Traces.	2.00	3.55
38	May 11	0.4	do	0.65	0.0004	0.36	Traces.	3.70	3.55
39	May 19	0.4	do	1.28	0.0007	0.64	0.260		7.10
40	May 29		do	0.32	Traces.	0.04	Traces.		7.10
41	June 5	0.25	do	0.64	0.016				10.65
42	June 6	0.75	do	0.64	0.0001	0.08	Traces.		3.55
43	June 7	0.08	do	0.64	0.0002	0.98	Traces.		3.55

12 inches of snow=1 inch of rain.

The results of the school year 1930–31 are expressed in Tables 1 and 2. The numbers indicate the parts of the various substances in a million parts of water.

TABLE 2.—*Data from Table 1 converted to pounds per acre*

[1 inch of rain over 1 acre=226,875 pounds]

No. of sample	Nitrates	Nitrites	Free ammonia	Albuminoid ammonium	Sulphates	Chlorides
1	05.445	00.680	07.62	Traces.		01.9312
2	03.803	Traces.	02.268	Traces.		00.40257
3	20.418	Traces.	Traces.	Traces.		05.304
4	18.150	Traces.	Traces.			01.20771
5	50.819	Traces.	Traces.	00.244		
6	43.522	Traces.	Traces.	Traces.		09.656
7	01.452	00.9075	Traces.			01.12344
8	06.534	04.080	05.508	Traces.		02.896
9	03.630	Traces.	04.536	Traces.		
10	29.040	Traces.	36.300			17.48
11	18.150	22.680				01.8144
12	27.588	00.431	Traces.			13.792
13	21.780	01.70	10.88	15.827	0.0204	05.44
14	02.904	Traces.	03.262			00.810
15		00.8715	03.407	01.9068		
16	03.176	09.639	04.536	06.804	0.025	01.4175
17	14.520	02.268	Traces.	Traces.		05.6725
18	05.808	09.075	18.15	Traces.		
19	09.5832	Traces.	05.850	03.745		
20	04.356	10.88	03.944	02.176		
21	10.164	15.90	04.293	Traces.		02.26
22	02.9765	Traces.	01.488	01.395	0.02232	01.674
23	04.352	04.764	01.4231	00.3045	0.109354	
24	04.352	01.588	04.7936	00.2247	0.3206	00.265
25	03.630	00.5675	08.1868	10.89	0.124	00.6010
26	08.712	03.176	53.928	02.996	0.1378	00.265
27	03.811	03.176	30.464	06.664	0.07072	00.0414
28	04.352	03.176	02.996	04.794	0.0509	00.532
29	14.6125		11.344	11.344		02.014
30		165.376	18.1250	16.66		00.242
31	01.452	29.040			0.06807	00.242
32	11.616		54.45	05.808		00.322
33	11.616	01.815	94.380	04.45		00.633
34	07.260		126.080	18.144		00.403
35	07.260	01.134	36.288	15.4224		00.403
36	01.452	02.27	20.421	11.118		00.1611
37	14.520	02.268	62.370	Traces.		00.403
38	05.898	03.630	32.670	Traces.		00.322
39	11.616	06.3525	58.080	02.359		00.645
40				Traces.		
41	03.630	90.72				00.607
42	10.8896	1.70	13.60	Traces.		00.604
43	01.161	0.363	17.756	Traces.		00.065

INTERPOLATION OF RAINFALL BY THE METHOD OF CORRELATION [1]

By C. E. GRUNSKY

It was in 1885 that it fell to me, as assistant State engineer, to prepare a rainfall map of this State. Records were available at 200 or more stations. It was found that at a large number of these stations observations had commenced in 1871 and that for this group of stations the records, covering 14 years and kept under the supervision of railroad employees, were fairly good. There were only a few widely scattered places in the State at which rainfall records extended back over more than 30 years. It was, therefore, determined to ascertain from each available record the average annual rainfall for this 14-year period and to let the isohyetal lines on the map represent the average rainfall at any point for this period.

[1] The article by Eric R. Miller under the above title, published in this REVIEW, 59: 35, has elicited the account herewith of a method of interpolation followed many years ago in California by Mr. C. E. Grunsky, of C. E. Grunsky Co., engineers, 57 Post Street, San Francisco, Calif. Mr. Grunsky's letter is given above.—*Ed.*

When at any station there was no record for some individual month, recourse was had to the records at near-by stations to approximate the lacking figures. For each such near-by control station the relation of the particular month's rainfall to that of the station's average annual rainfall was then ascertained. The 14-year period only was taken into account in estimating this relation. According to proximity or to similarity of topographic and orographic features, the several approximations thus obtained always expressed in per cent of normal annual rain (in this case the 14-year average), were weighted and were then used to establish the missing record expressed in percentage of the annual normal. This percentage applied to the station normal thereupon determined the desired amount in inches.

At some stations the record covered only a part of the 14-year period. In each such case the incomplete record was compared with the records for corresponding periods at such near-by stations as had complete records. The relation established by this comparison was accepted as the relation between the normal rain at the particular station in question and the normal rain at the control station. If several control stations were brought into consideration the several individual results were weighted, as explained, not by methods of least squares, but according to personal judgment, and the result was accepted with confidence.

It is to be noted, however, that the relation between the amounts of rain at near-by stations is much more likely to be fairly constant in California where the rain producing cyclones are generally of vast extent than would be expected where much rain falls during storms which cover only small areas.

Any refinement of calculation to give better results than can be obtained by the foregoing simple method is never warranted. This will appear when it is considered that the best that can be done is to secure an approximation. The records of the past are, moreover, generally required to serve only as a basis for a prediction of what may be expected to happen in the future. There is, furthermore, always so much uncertainty in the premises that no intricacy of calculation can give any more dependable results than the simple comparison above described.

TESTS OF RAINFALL-INTERPOLATION METHODS

ERIC R. MILLER

[Weather Bureau, Madison, Wis.]

The results of applying to some difficult cases the method of interpolation of rainfall data recommended in the MONTHLY WEATHER REVIEW, January, 1931, may be of interest to meteorologists on account of the light thrown on some unusual rainfall phenomena.

Figure 1 is a scatter diagram showing the correlation of the monthly rainfall in June for 33 years between 1895 and 1930 at Center Hall and State College, Pa., about 10 miles apart. The correlation coefficient for all cases is 0.52; excluding the cases of 1909, 1922, 1930, it is 0.84. Examination of the records shows that local downpours occurred at one or other of the stations in the excluded cases.

A similar diagram for June rainfall, 34 years between 1888 and 1930, for Titusville and Merritts Island, Fla., 17 miles apart, Figure 2, shows that the incoherence that affected only 3 of the 33 cases in Pennsylvania has here spread to the whole group. In spite of this, the wider range of values gives a higher coefficient, 0.61.

A third type of correlation, close for small values, dispersed for large, is shown in Figure 3, January rainfall, 20 years, 1897–1916, Campbell and Boulder Creek, Calif. About 15 miles apart, chosen on account of the large difference in their average January rainfalls, 4.07 and 14.65 inches, respectively.

Mr. C. E. Grunsky, the well-known engineer, has suggested comparison of the regression method of estimating

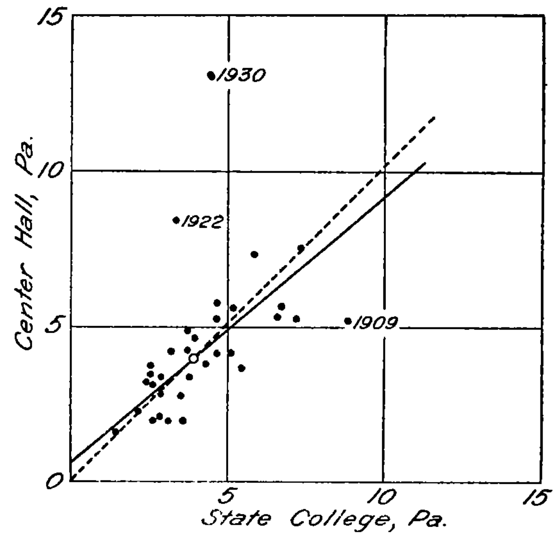

FIGURE 1.—Scatter diagram showing correlation of monthly total rainfall for June for 33 years

rainfalls with a method that he devised in 1885 when, as assistant State engineer of California, it devolved upon him to prepare a rainfall map of the State. The basis of his method is the assumption that the ratio of rainfalls

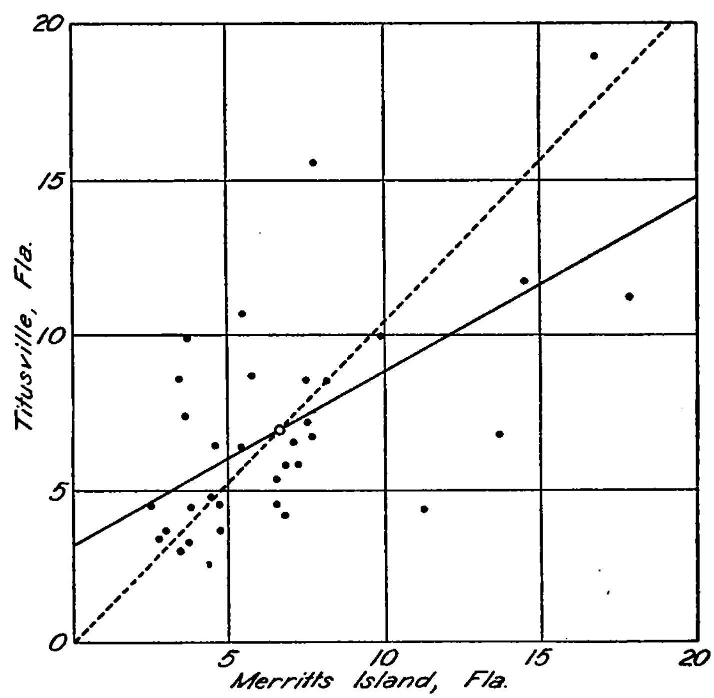

FIGURE 2.—Scatter diagram showing correlation of monthly total precipitation for June, 34 years

at neighboring stations is always the same as the ratio of the normals.

The regression equations minimize the sums of the squares of the deviations of the observed rainfalls from the computed. A suitable test of Mr. Grunsky's method consists in comparing the deviations of computed from observed rainfalls by the two methods.